8p

NASA TT F-8191

X63-11407
code-2d

RADIATION MEASUREMENTS IN THE OUTER RADIATION BELT ON 12 FEBRUARY 1961 DURING THE ROCKET FLIGHT TOWARD VENUS

by S. N. Vernov, A. E. Chudakov, P. E. Vakulov,
E. V. Gorchakov, and Yu. I. Logachev

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON March 1962

DRAFT TRANSLATION NASA TT F-8191

MAR 1 6 1962

RADIATION MEASUREMENTS IN THE OUTER RADIATION BELT ON 12 FEBRUARY 1961 DURING THE ROCKET FLIGHT TOWARD VENUS.

(Izmereniya izlucheniy vo vneshnem radiatsionnom poyase 12.II. 1961 g. pri polete rakety v storonu Venery)

Geomagnetizm i Aeronomiya
Tom I, No.6,
pp. 872-874,
Izd-vo A.N.SSSR, Moskva, 1961.

by S. N. Vernov,
A. E. Chudakov,
P. V. Vakulov,
E. V. Gorchakov,
Yu. I. Logachev.

ABSTRACT

This paper examines the results of the experiment carried out on 12 February 1961 during the flight toward Venus of the automatic interplanetary station. A comparison is made of the results so obtained with those of some other flights, including those of American "Explorer IV" and "Explorer VI". A two-year stability of the exterior boundary of the outer radiation belt is revealed.

COVER-TO-COVER TRANSLATION

The apparatus used for the investigation of radiations aboard the automatic interplanetary station flying toward Venus, consisted of a scintillation and gas-discharge counters. A 20 x 20 mm^2 cylindrical NaJ(Tl) crystal was used as the scintillation counter detector. The STS-5-

type gas-discharge counter was 5 cm long and 1 cm in diameter. The counter's wall was made of stainless steel 50 mg/cm^2 thick. Neither the gas-discharge, nor the scintillation counters were especially shielded. Both were disposed inside a hermetic container. The aggregate thickness of container's casing and device's walls constituted near 5 mm. Al. The substance distribution around the crystal and the gas-discharge counter is presented in the above Table.

Screen g/cm^2	Over-all solid angle	
	crystal	counter
< 1.5	~30	~25
1.5 ÷ 10	~10	~15
>10	~60	~60

The total energy liberation in the crystal was registered by the scintillation counter, and so was the count number of cases, when the liberation of energy in the crystal exceeded 30 keV. Since the radiation intensity in the outer belt is exceedingly high, and in order to achieve a more reliable registration by the scintillation counter in comparison with preceding experiments, the linear dimensions of the crystal were diminished twofold, while the electronic resolving power was increased. Overload characteristics for the counting channel of the scintillation counter 1, and of the gas-discharge counter 2, are plotted in Fig. 1. It may be seen hence, that up to 10^6 counts per sec may be accurately measured by the scintillation counter,

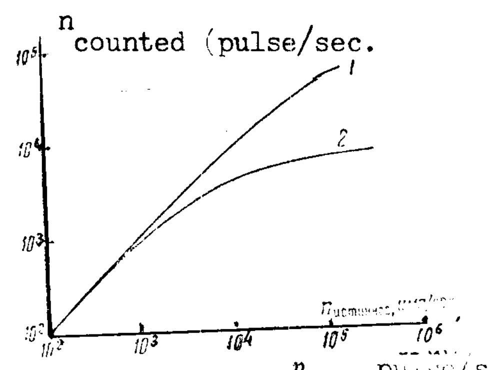


Fig. 1

and up to 10^5 — by the gas-discharge counter's channel.

Discussed are in the present paper data obtained at the first session of telemetric communication with the interplanetary station, on 12 February 1961, during which it was drifting within the outer radiation belt, some 30 to 45 thousand kilometers from the center of the Earth.

In order to be able to penetrate into the crystal of the scintillation counter, and into the operating area of the gas-discharge counter, electrons must have energies $\geqslant 3$ MeV, protons — $E \geqslant 32$ MeV, and brehmstrahlung ouanta — $E \geqslant 30$ keV. It was shown during the flight of the 2nd cosmic rocket that there are practically no electrons with $E > 3.5$ MeV, while the spectrum of electrons in the region of high energies is very steep, so that it may be estimated that the measuring devices of the

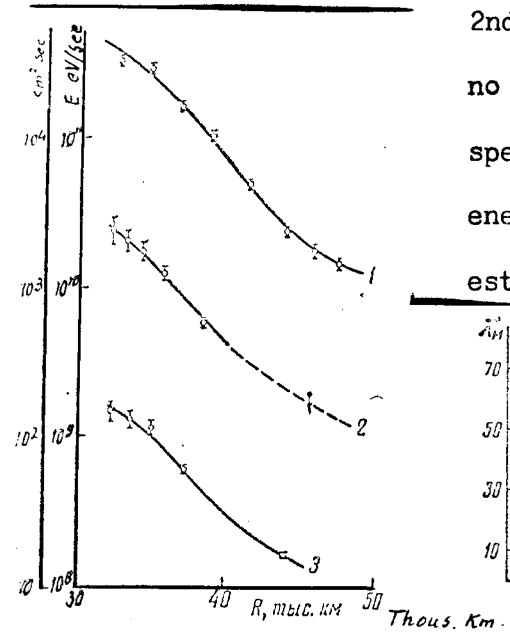


Fig. 2

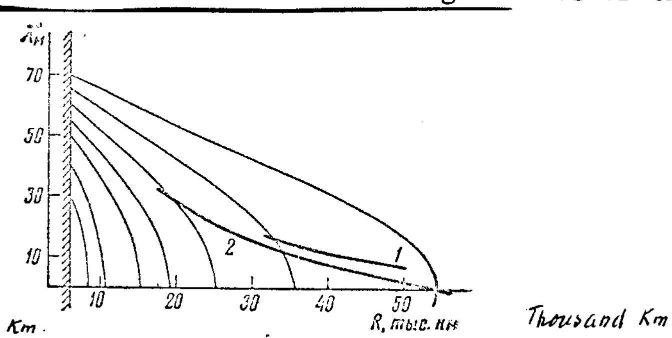


Fig. 3

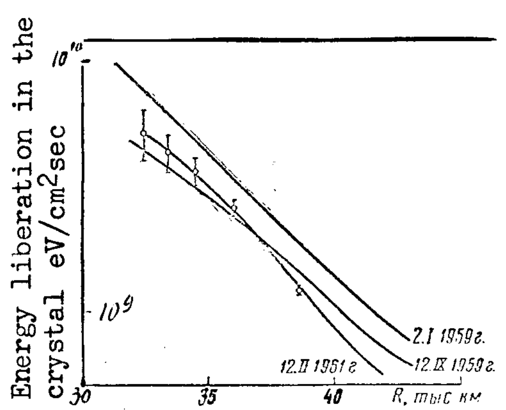
automatic interplanetary station registered within the radiation belt only electron brehmstrahlung and cosmic rays. This is in contrast to what was obtained by means of the devices aboard the first cosmic rocket, which could also register a certain part of high-energy electrons.

Counting rates of the gas-discharge (curve 3) and scintillation counter (curve 1) are plotted in Fig. 2, after introducing the relevant correction according to overload curves and the total energy liberation in the crystal (curve 2) as a function of the distance from the center of the Earth (the number of pulses is related to the surface unit of the transverse cross section of the crystal and of the counter, respectively 4.7 and 4.3 cm^2. Meanwhile, the interplanetary station already passed the maximum intensity region, and was at the time at the edge of the outer radiation belt.

Within the bounds of errors, all three curves run parallel to one another along the total extension. This means that the average energy liberation in the crystal for a single count of the scintillator, equal to 130 keV, remains constant over distances from 32 000 to 40 000 km and that the mean energy of brehmstrahlung quanta, occurring in the casing of the interplanetary station, does not vary with the distance.

The mean energy liberation in the crystal, corresponding to a single scintillator's count, depends little on the form of the energy spectrum of electrons creating the brehmastrahlung registered by the crystal. That is why, the constancy of that magnitude in the 32 — 40 000 km distance range, points to the fact that no strong variation of electron spectrum of the outer radiation belt takes place within it. This is also corroborated by the constant counting rate ratio of gas-discharge to scintillation counters over various distances.

Beginning with 1959, measurements were carried out at four flights through the outer radiation zone by close trajectories. In Fig.3, the trajectory of the interplanetary station is represented by the curve 1; the trajectory of the flight of the 1st, 2nd and 3rd cosmic rockets — by curve 2. In three cases the state of the magnetic field of the Earth was quiet, but during the flight of the 3rd cosmic rocket, a moderate magnetic storm took place several hours before take-off (variation of the vertical and horizontal components of the Earth's magnetic field, 250 and 150 respectively). The easiest way of comparing the state of the outer radiation belt during these measurements, is by magnitude of ionization caused in the crystals of the scintillation counters. Fig.4 presents the values of energy liberation in the NaJ(Tl) crystals along the flight trajectories of the 1st and 2nd cosmic rockets, and that of the flight of 12 February 1961, plotted by the crystals' transverse cross section unit per second (respectively 19 cm^2 for the 1st and the 2nd cosmic rockets, and 4.7 cm^2 for the flight of 12 February 1961).



Thous'd km

Distance from the center of the Earth.

Fig.4

The close course of ionization curves for these three flights suggests that the outer radiation zone remained stable during more than two years in the absence of magnetic disturbances. Despite this term being insufficient for an estimate of the effect of solar activity on the outer radiation belt of the Earth, it nevertheless provides preliminary indications on the possible absence of such effect. Assuming that the Sun is the initial basic source of particles of the outer radiation belt, the independence of the its state from the solar activity cycle leads to particle lifetime exceeding many times that of solar activity cycle's duration. This conclusion was brought out in the work ref. [1]. But if the basic source of particles is in the albedo neutrons, the intensity of the radiation belt must increase with the decrease of solar activity. However, this effect is small, and a lengthy observation of the state of radiation belts is required for its detection.

The flight of the 3rd cosmic rocket took place under conditions of moderate Earth's magnetic field disturbance. No measurements at the exterior part of the outer radiation belt were conducted in the course of that flight, but the aggregate energy liberation in the crystal for the flight time through the outer radiation zone was however determined. It coincided with the aggregate energy liberation measured during the flight of the first cosmic rocket, and it resulted 1.5 times lesser than at the flight of the 2nd cosmic rocket. This means, that the average state of the outer zone did not vary during the flight of the 3rd rocket, during the magnetic storm of moderate intensity, either.

Measurements in the outer radiation belt during magnetic storms, carried out during the flights of American satellites "Explorer IV" [2] and "Explorer VI" [3], have shown, that the intensity in the zone at great distances from the Earth diminishes 2 to 3 times 24 hours after the commencement of the magnetic storm. In our case, measurement was carried out only a few hours after the commencement of the storm, when the decrease in intensity may possibly have not begun yet. Another interpretation would consist in the assumption that every magnetic storm does not necessarily cause a decrease in intensity in the inner radiation belt, and that the given storm is thus related to the non-effective group.

****** THE END ******

REFERENCES

1. W. H. HESS., J. Geophys. Res., 65, No. 10, 3107, 1960.
2. P. ROTHWELL, C. E. McILLWAIN, J. Geophys. Res., 65, No.3, 799, 1960.
3. R. L. ARNOLDY, R. A. HOFFMAN, J. R. WINCKLER, Ibid. 65, No.5, 1361, 1960.

Moscow State University
Institute of Nuclear Physics

Entered on
9 September 1961.

Translated by ANDRE L. BRICHANT.
for the
National Aeronautics and Space Admin'n.

16 March 1962.